Wind Engineering Joint Usage/Research Center
FY2018 Research Result Report

Research Field: Indoor environment
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Research Theme: Experimental investigation on moisture buffering value of hygroscopic MPCM under different airflow conditions

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Budget [FY2018]: 200,000Yen

*There is no limitation of the number of pages of this report.
*Figures can be included to the report and they can also be colored.
*Submitted reports will be uploaded to the JURC Homepage.

1. Research Aim

The objective of this study is to prepare composite hygroscopic materials with both temperature and humidity regulation performance, and to investigate their moisture buffering effect under different airflow conditions.

2. Research Method

It is assumed that the air outlets in actual rooms are arranged on the wall; in this case, the samples are divided into two groups — one group located parallel to the ceilings and floors, and another group located vertical to the air supply orientation.

All the experiments were conducted in a test chamber (size: 8.0 m × 3.7 m × 2.7 m), located in a climate room that could create a precise temperature and humidity environment. Fig. 2 shows a schematic of the test chamber and the climate room. The settings of temperature and humidity in the climate room are based on the NORDTEST method [21], which will be mentioned below. There is an airflow generating device in the test chamber, constituted by 48 fans to ensure uniform air supply. The experimental cases include 0 m/s, 0.5 m/s, 1.0 m/s, and 1.5 m/s, corresponding with practical air supply — static condition, slow airflow velocity, medium airflow velocity, and high airflow velocity. Fig. 3 shows the setting of each sample during the experiments.

Before every experiment, each sample should be put into a steady environment (23±0.5 ℃, 50±5%) for pretreatment until a constant mass is achieved. The experiment includes two phases: 1) Absorption phase: each sample was put into the test chamber (23 ℃, 75%) for 8 hours and weighed by an electronic balance (AND GF-6100, accuracy: ±0.1g) to measure its weight variation. 2) Desorption phase: the humidity of the climate room was changed to 33% while the temperature remained 23 ℃. The weight variation of each sample was measured for 16 hours. The air-flow condition remained the same during both two phases.

The temperature, relative humidity, and airflow velocity were monitored by using testo 480 and its matching probes — temperature and humidity probe (accuracy ±0.2℃, ±2%RH), hot-wire anemometer (accuracy ± (0.1m/s+5% measured value)).

3. Research Result

The maximum moisture ab/desorption of each sample increased as the airflow velocity increased. The moisture absorption of the vertical group samples always exceeded the parallel group samples, while the moisture desorption of the vertical group samples were almost identical to the parallel group samples.

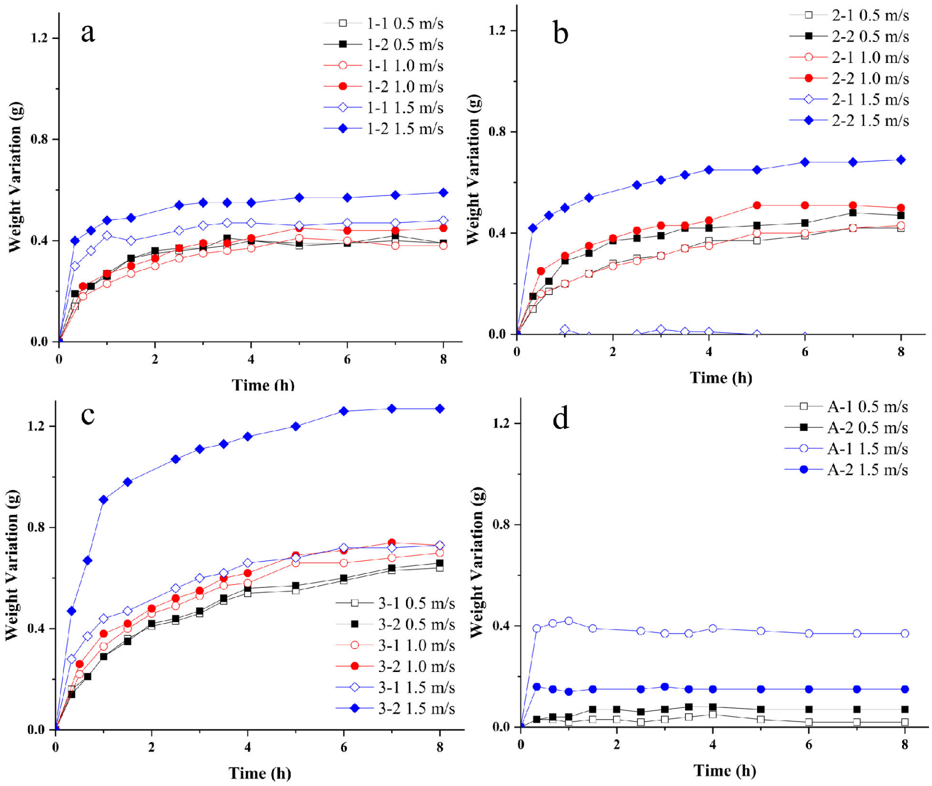

Fig. 1. (a)-(d) Weight variation under different airflow conditions in the absorption process

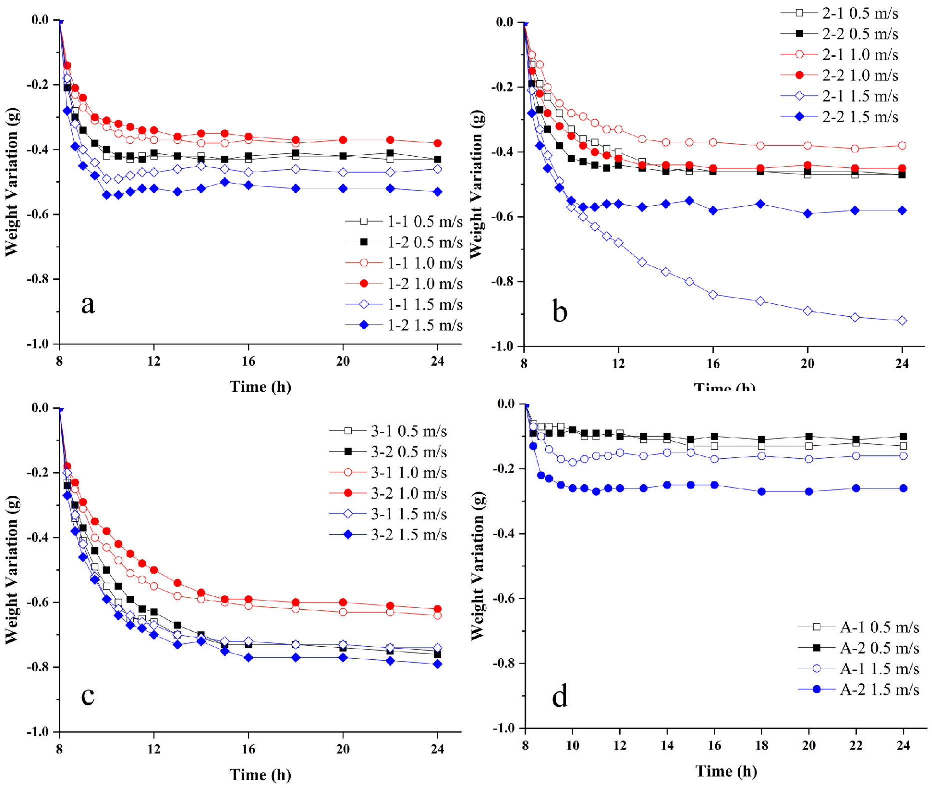

Fig. 2. (a)-(d) Weight variation under different airflow conditions in the desorption process

The MBV_{ideal} of CMPCM-15 was the highest, followed by PG and CMPCM-5, while the MBV_{ideal} of BP was the smallest. The moisture buffering effect of composite hygroscopic

MPCM was weak when 5% of MPCM was added, but it could be enhanced significantly when the figure was raised to 15%.

The $MBV_{practical}$ of each sample increased significantly when the airflow velocity was increased, and the values of the samples vertical to the airflow orientation increased faster, compared to that of the samples parallel to the airflow orientation. In addition, the MBV_{ideal} of each sample is slightly larger than $MBV_{practical}$ when the environmental airflow velocity is 0.

4. Published Paper etc.

1. Chengnan Shi, Huibo Zhang, Jingwen Rui, Ya Chen, Yingli Xuan, Weirong Zhang. An experimental investigation of moisture buffering value for composite hygroscopic materials under different air-flow conditions, 11th International Symposium on Heating Ventilation and Air Conditioning (ISHVAC 2019)
2. Chengnan Shi, Huibo Zhang, Yingli Xuan. Experimental investigation on moisture buffering value of hygroscopic MPCM under different airflow conditions, Building and Environment (Submitted)

5. Research Group

1. Representative Researcher
   Huibo Zhang
2. Collaborate Researchers
1. Yingli Xuan
2. Chengnan Shi
3. Yoshihide Yamamoto

6. Abstract (half page)

Experimental investigation on moisture buffering value of hygroscopic MPCM under different airflow conditions

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Summary:
The moisture absorption of PG, CMPCM-5, CMPCM-15, and BP increased as the environmental airflow velocity was increased. Under the same airflow velocity, the moisture absorption of the vertical group samples always exceeded that of the parallel group samples, especially when the airflow velocity was high (1.5 m/s). In addition, the moisture absorption of CMPCM-15 was higher than that of PG and CMPCM-5 in each case.

The moisture desorption of PG, CMPCM-5, and CMPCM-15 were the largest when the airflow velocity was 1.5 m/s. Under the same airflow velocity, the moisture desorption of the vertical group samples was almost identical to that of the parallel group samples. In addition, the difference in moisture absorption between PG, CMPCM-5, and CMPCM-15 was limited during each case. Moreover, the maximum moisture desorption of BP increased as the environment airflow velocity was increased.

The $MBV_{practical}$ of PG, CMPCM-5, CMPCM-15, and BP increased as the environment airflow velocity was increased, while the $MBV_{practical}$ of the vertical group samples exceeded that of the parallel group samples. When the environmental airflow velocity was 1.5 m/s, PG, CMPCM-5, and CMPCM-15 could reach a moderate level or even higher. Although the thickness of BP is only one-twentieth that of the others, $MBV_{practical}$ of BP is one-third that of the others, and is even close to that of PG when the environmental airflow velocity was 1.5 m/s, reaching almost 0.5 g/m^2%RH.